

**FIBER-REINFORCED SANDWICH PANEL**

**BACKGROUND OF THE INVENTION**

**Field of the Invention**

The present invention relates to prefabricated structures, and more particularly, to fiber-reinforced sandwich panels for ease of manufacture of prefabricated structures.

**Description of the Prior Art**

Concrete is a preferred building material for construction of structures in certain markets. Load-bearing concrete walls are generally thick, heavy, and difficult to transport. Also, an un-insulated concrete wall generally has a poor insulation value and increasing the insulation value of the concrete wall may be problematic. Accordingly, a prefabricated structure manufactured using concrete may not be economically viable in certain markets.

Accordingly, there exists a need for a lightweight and relatively low-cost prefabricated structure for competing in markets preferring concrete structures. The present invention satisfies these needs.

**SUMMARY OF THE INVENTION**

The present invention is embodied in a fiber-reinforced sandwich panel and a unique composition for the manufacture of prefabricated buildings. The sandwich panel includes first and second face panels, a support frame, and embedded insulation. Each of the first and second face panel has a first predetermined thickness and is formed of a fiber-reinforced cementitious material. The support frame supports the first and second face panels in a spaced apart configuration. The support frame is formed of a fiber-reinforced cementitious material that is continuous with the cementitious material of the first and second face panels. The block of embedded insulation defines a structure of the support frame.

In more detailed features of the invention, the sandwich panel may have a height greater than 6 feet, a width greater than about 8 feet, and a thickness between about 3.5 and 5 inches. The thickness of the first panel may be between about 0.375 inches and 1.0 inch, and the thickness of the second panel likewise may be between about 0.375 inches and 1.0 inch. The support frame may have an upper border beam, a lower border beam, and first and second border

1 beams that encompass the insulation. The support frame may further include one or more ribs  
2 that have a length extending between the lower border beam and the upper border beam, and that  
3 are substantially parallel with the first and second end beams. The ribs may couple the first and  
4 second face panels along the length of the ribs. Each of the beams may have a width of about 4  
5 inches, and each of the ribs may have a width of about 2.5 inches. Also, each border beam may  
6 be further strengthened by reinforcing bar. The insulation block may be rigid. The cementitious  
7 material may have a composition, by weight before cure, of about 42.3% cement, about 42.3%  
8 sand, about 1.0% polypropylene fiber, about 0.1% superplasticiser and about 14.3% water.

9 In other more detailed features of the invention, the sandwich panel may include an  
10 opening formed by first and second jamb beams that extend between the lower border beam and  
11 the upper border beam, and by a sill beam and a header beam that each extend between the first  
12 and second jamb beams. The first and second jamb beams are substantially parallel with the first  
13 and second end beams and the sill beam and the header beam are each substantially parallel with  
14 the lower and upper border beams.

#### **BRIEF DESCRIPTION OF THE DRAWINGS**

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16  
17 The accompanying drawings illustrate embodiments of the present invention and,  
18 together with the description, serve to explain the principles of the invention.

19 FIG. 1 is a perspective view of a fiber-reinforced sandwich panel, according to the present  
20 invention.

21 FIG. 2 is a cross-sectional elevation view of the fiber-reinforced sandwich panel of  
22 FIG. 1, showing a frame structure behind a face panel.

23 FIG. 3 is a cross-sectional plan view of the fiber-reinforced sandwich panel of FIG. 1.

24 FIG. 4 is a perspective view of a fiber-reinforced sandwich panel having an opening,  
25 according to the present invention.

26 FIG. 5 is a cross-sectional elevation view of the fiber-reinforced sandwich panel of  
27 FIG. 4, showing a frame structure behind a face panel.

28 FIG. 6 is a cross-sectional plan view of the fiber-reinforced sandwich panel of FIG. 4,  
29 showing a jamb of the opening.

FIG. 7 is a cross-sectional elevation view of the windowed fiber-reinforced sandwich panel of FIG. 4, showing a header of the opening.

### **DETAILED DESCRIPTION**

With reference to FIGS. 1-3, the present invention resides in a fiber-reinforced sandwich panel 10 having a lightweight and cost-effective construction. The sandwich panel is formed of a unique cementitious material that allows it to be insect resistant and generally impervious to moisture. Rigid blocks 12 of insulation are embedded in the sandwich panel to provide a desired insulation value to the sandwich panel and to define a support frame 14 that meets desired structural parameters for the sandwich panel.

The sandwich panel 10 may be constructed by pouring a first layer of the cementitious material into a mold (not shown) for forming a casting face panel 15. The rigid insulation blocks 12 are then placed on the first layer. The blocks are sized to define the size of ribs 16 between the blocks and border beams, 18, 20, 22 and 24, around the edge of the sandwich panel. Small nylon spacers (not shown) are placed between the mold and the insulation blocks to define the thickness of the casting face panel. Reinforcing bars 26 may be placed in the spaces for the border beams that surround the insulation blocks for adding structural strength to the border beams and the sandwich panel. The rebar may extend a few inches outside of the sandwich panel to assist in handling the sandwich panel and for attaching the panel to other structural members. The ribs extend between the upper border beam 18 and the lower border beam 20 and are substantially parallel with the border beams, 22 and 24, at the ends of the sandwich panel. The ribs provide support to the face panels, 15 and 28, and assist in the load bearing characteristics of the sandwich panel.

After placement of the insulation blocks 12 on the first layer, additional cementitious material is poured between, surrounding, and over the blocks to form the border beams, 18, 20, 22 and 24, and the ribs 16. The cementitious material that is poured above the blocks forms an upside face panel 28. Accordingly, the cementitious material forms the face panels 15 and 28, and the support frame 14. After the sandwich panel has initially cured, it is removed from the mold.

The sandwich panel 10 may have a wide variety of configurations for the size of the beams, 18, 20, 22 and 24, the width and spacing of the ribs 16, and the thickness of the casting face 15 and upside face panel 28. A representative sandwich panel may have a width of 16 feet (ft.), a height of 10 ft., and a thickness of 4.25 inches (in.). In conjunction with the sandwich panel thickness of 4.25 in., the beams each may have a width of 4 in., and the ribs may each have a width of 2.5 in. The spacing between the first end border beam 22 and the first adjacent rib of the wall panel may be 18 in. Similarly, the spacing between the second end border beam 24 and the first adjacent rib may be 18 in. The spacing between the ribs may be 26 in. on center.

The cementitious material is reinforced using glass, synthetic, or similar fibers, to provide added structural strength to the sandwich panel 10. A representative composition by weight (uncured) for the cementitious material is provided by the following table:

<u>Table 1 (% by weight – uncured)</u>	<u>Preferred</u>
Cement	42.31 %
Sand	42.31 %
Polyfiber	0.95 %
Superplasticizer	0.13 %
Water	14.30 %

The polyfiber may be polypropylene fiber cut to lengths of about 0.5 in. to 1.5 in. before mixing with the other materials. The superplasticiser may be Rheobuild® 3000FC, available from Master Builders, Inc. or Cleveland, Ohio. Other formulations for the cementitious material are described in U.S. Patent No. 6,073,410, titled STRUCTURE AND FORMULATION FOR MANUFACTURE OF PREFABRICATED BUILDINGS. U.S. Patent No. 6,073,410 is incorporated herein by reference. A polymer may be added to the mix or sprayed on the poured sandwich panel 10 to assist hydration of the cementitious material during cure under low humidity conditions or to enable early handling of the panel. Under controlled environmental conditions, the polymer may be eliminated.

With reference to FIGS. 4-7, the fiber-reinforced sandwich panel 10 of the invention may have an opening 30 for a window or similar passage. As shown in FIG. 5, the opening is

1 surrounded by a header beam 32, a sill beam 34, and first and second jamb beams, 36 and 38.  
2 The first and second jamb beams provide support for the upper border beam 18, the header beam  
3 32, and the sill beam 34. Further, the first and second jamb beams, the header beam, and the sill  
4 beam may be reinforced with bars 26 to provide additional structural strength surrounding the  
5 opening in the sandwich panel.

6 A representative sandwich panel 10 with an opening 30 may have height of 10 ft., a width  
7 of 16 ft., and a thickness of 4.625 in. The casting face panel 15 and the upside face panel 28 may  
8 each have a thickness of 0.625 in. The opening in the sandwich panel may have a width of 8 ft.  
9 and a height of 4 ft., with the bottom of the opening being 2.5 ft. the from the bottom of the  
10 sandwich panel. Each rib 16 may have a thickness of 2.5 in. and may be spaced between the  
11 respective end border beam, 22 or 24, and respective jamb beam, 36 or 38, by 24 in.

12 The fiber-reinforced cementitious material allows the relatively thin casting face panel  
13 and upside face panel 28 to have a relatively high strength. The insulation blocks 12 provide a  
14 high insulation value to the sandwich panel 10. The sandwich panel has an appearance and  
15 impression similar to that of a concrete structure. The configuration of the beams and ribs, and  
16 the placement of the reinforcing in the beams, allows the frame 14 of the sandwich panel to have  
17 sufficient load-bearing capacity to support a roof structure, additional floor level, or the like.  
18 Accordingly, the fiber-reinforced sandwich panel of the present invention provides a cost-  
19 effective and relatively lightweight, insulated panel for the construction of prefabricated  
20 structures or the like.

21 While the invention has been illustrated and described in detail in the drawings and  
22 foregoing description, it should be understood the invention may be implemented though  
23 alternative embodiments within the spirit of the invention. Thus, the scope of the invention is  
24 not intended to be limited to the illustration and description in this specification, but is to be  
25 defined by the appended claims.